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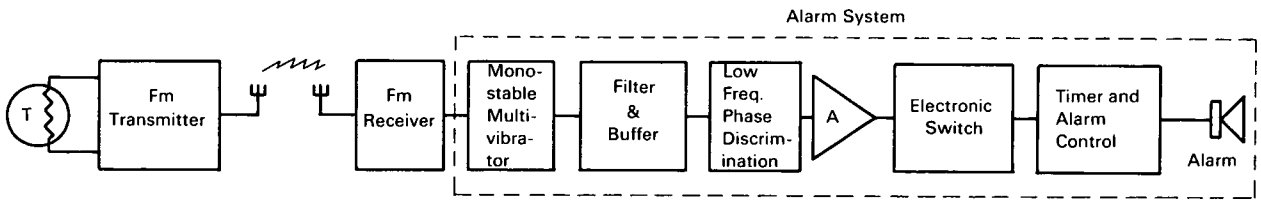
Automatic Patient Respiration Failure Detection System with Wireless Transmission



The problem:

Infants or comatose children and adult patients sometimes require a tracheostomy tube which is surgically implanted in the patient's windpipe to ease breathing difficulties. Because of the ever present danger of the tube becoming clogged and suffocation resulting, a continuous visual watch by a nurse is required to detect respiration failure and to take immediate corrective action. This is not only expensive, but even with continuous surveillance, there is always the possibility that the nurse might be distracted for the short interval (2–4 minutes) necessary for brain damage or death to result from lack of sufficient oxygen.

The solution:

An automatic Respiration Failure Detection System which immediately recognizes respiration failure or partial failure and ten seconds later, actuates an audible and/or visual alarm. The system incorporates a miniature radio transmitter so that the patient is unencumbered by wires yet can be monitored from a remote location such as a nurse's station or a room other than the patient's room at home.

How it's done:

The temperature sensor–FM transmitter is attached directly to the tracheostomy tube, thereby allowing the inspired and expired air to flow directly over a thermistor temperature sensor. This sensor responds to differences in the temperature of the airflow through changes in its resistance. The FM transmitter has a nominal subcarrier pulse frequency which increases as the thermistor resistance decreases with increasing temperature. An FM receiver is used to receive the respiration signal. The pulsed receiver output is used to trigger the alarm system. The first stage in the alarm system is a monostable multivibrator which provides amplitude discrimination against changes in the level of the receiver output signal. This output is filtered, buffered by an emitter follower and coupled to a low frequency phase discriminator which serves as a frequency-to-voltage converter. The voltage changes caused by respiration are amplified with an adjustable gain of approximately 2 to 23 and are used to actuate an electronic switch which provides a reset pulse for each respiratory cycle considered to be of sufficient length (as determined by the setting of the amplifier gain control). The reset pulse is used to discharge a capacitor that serves as the timing element of the alarm control. If the capacitor does not receive a reset pulse for a preselected time (arbitrarily chosen to be 10 seconds), the alarm control actuates an audible and/or visual alarm. A "Reset-Normal" switch is provided that turns off the alarm when placed in the "Reset" position and allows 1½ minutes to clear any obstruction in the tracheostomy tube. At the end of this time interval, the alarm will sound

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again and will continue to operate until the "Reset-Normal" switch is again placed in the "Normal" position and a proper respiratory signal is received.

Notes:

1. The system could be used to monitor normal nose-mouth breathing by the use of an air-directing mask which directs the flow of respiratory air across the thermistor temperature sensing element.
2. Since the lead length of the thermistor is "non-critical" to circuit operation, the thermistor need not be located near the transmitter. Any cyclic point temperature could be monitored for gross variations and could be used to trigger the alarm system if arbitrary limits are exceeded.
3. A prototype system has been assembled largely from components developed for space research purposes. First trials of this equipment to monitor the respiration of human patients have been conducted at Children's Hospital Medical Center, Oakland, California after initial experiments on a young dog. The patients, all children, had tracheostomy tubes implanted and ranged in age from 6 weeks to 4 years. These trials, conducted under continuous monitoring by a doctor or a nurse, are continuing with excellent results. An indication of the sensitivity of the apparatus is provided by the fact that it was successfully used to monitor the respiration of a six-week old child that was housed in an isolette where the temperature is maintained at 85°F.
4. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: B68-10365

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: Jack M. Pope and John Dimeff
(ARC-10174)